NON-PUBLIC?: N
ACCESSION #: 9003270415
LICENSEE EVENT REPORT (LER)

FACILITY NAME: PRAIRIE ISLAND NUCLEAR GENERATING PLANT PAGE: 1 OF 10

DOCKET NUMBER: 05000306

TITLE: Unit 2 Reactor Trips and Loss of Power to Reactor Coolant Pumps
EVENT DATE: 12/21/89 LER #: 89-004-01 REPORT DATE: 03/19/90

OTHER FACILITIES INVOLVED: Prairie Island Unit 1 DOCKET NO: 05000282

OPERATING MODE: N POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(i)

LICENSEE CONTACT FOR THIS LER:
NAME: Arne A Hunstad, Staff Engineer TELEPHONE: (612) 388-1121

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: FX COMPONENT: BKR MANUFACTURER: G080
X AA W120
REPORTABLE NPRDS: YES
YES

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

Unit 2 tripped on December 21, 1989, from what appeared to be faulty voltage regulation by one of the control rod drive mechanism motor-generator sets. One substation circuit breaker did not operate properly and power was lost to non-safeguards 4KV buses, which supply the reactor coolant pumps. The reactor was cooled by natural circulation for about 3 hours. The voltage regulator for the MG set was replaced and tested. Since the outdoor temperature at the time of the trip was -22 degrees F, the cold was blamed for the breaker malfunction. Heating was applied to the substation breakers and testing showed proper operation. The unit was restarted. On December 26, 1989, a nearly identical trip and loss of non-safeguards 4KV buses occurred. Extensive investigation uncovered malfunctions in the MG sets, in the rod control system, and in the substation breaker control system. After repairs and extensive

testing, Unit 2 was returned to service on January 10, 1990.

END OF ABSTRACT

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EVENT DESCRIPTION, CAUSE AND CORRECTIVE ACTIONS

On December 21, 1989, Unit 2 was operating at 100% power.

At approximately 0223 hours the reactor tripped. Subsequent to the trip, power to the Unit 2 non-safeguards 4KV buses (EIIS Component Identifier BU), which supply the reactor coolant pumps, was not available due to failure of 345KV breaker (EIIS Component Identifier BKR) 8H13 in the substation. Both emergency diesel generators (EIIS Component Identifier DG) started but did not load since the Unit 2 safeguards buses remained powered by their alternate supplies. Power was restored to the non-safeguards buses, and the reactor coolant pumps, approximately three hours after the trip. Technical Specifications in effect on December 21, 1989 required one reactor coolant pump or one residual heat removal pump be inservice at all times. Technical Specifications allowed all pumps to be shutdown for up to one hour provided the reactor was subcritical, no dilution was in progress, and at least a 10 degrees F margin existed to saturation. All of the above criteria were met with the exception that the pumps were off for greater than one hour. Decay heat was being removed by the steam generators with the Reactor Coolant System in natural circulation.

There was no action statement for that section of the Technical Specifications. At the time of the event a revision to Technical Specifications had been approved, but not implemented, that added a section to address this issue. It states, consistent with standard Technical Specifications that when a Limiting Condition for Operation is not met and action is not specified, action must be initiated within one hour to place the unit in a condition where the equipment is not required. In this case the equipment in question was the reactor coolant pumps. The Reactor Coolant Pumps are required above 350 degrees F so the action would be to take the unit to less than 350 degrees F. The generic applicability statement goes on to require that for equipment required above 350 degrees F, the unit must be in hot shutdown within 6 hours and Reactor Coolant System temperature reduced below 350 degrees F within the following 6 hours.

Since the unit was in hot shutdown and pumps resorted prior to the 6 hour requirement for hot shutdown, the intent of the Technical Specifications were not exceeded.

Both the "first out" annunciator (EIIS Component Identifier ANN) and the computer sequence of events indicated that the cause of the reactor trip was a high flux rate trip from the nuclear instrumentation system. A (negative) high flux rate trip is consistent with a dropped rod or rods. A check of the rod drive motor-generator (MG)(EIIS Component Identifier MG) sets showed that the output breaker of No. 21 MG set was open. A check of the rod control system (EIIS System Identifier AA) showed that no fuses were blown.

Investigation of the rod drive MG set protective relaying showed that No. 21 MG set output breaker had tripped on instantaneous reverse current. The settings of the relays (EIIS Component Identifier RLY) were checked and found to be correct. Test tripping of the relays was also satisfactory. Wave form observation of both MG set voltage regulators (EIIS Identifier RG) was undertaken to determine if a defective regulator could have caused a loss of power to the rod drive system and a resulting dropping of rods. The wave forms appeared to be satisfactory. It was then decided to withdraw the shutdown bank control rods (a normal hot shutdown condition) for observation. The rods withdrew normally. Approximately three hours later, the rods fell into the core. The output breakers of both rod drive MG sets were checked and found to be open. No. 22 MG output breaker had tripped on instantaneous reverse current.

It could not be determined why No. 21 MG set output breaker had tripped.

Testing was performed to attempt to duplicate the conditions. By adjusting the voltages with the voltage regulators in manual, similar conditions could be reproduced. It was then concluded that No. 21 MG voltage regulator had failed to maintain proper voltage, resulting in degraded voltage to the rod control system and subsequent dropping of a rod or rods. This scenario coincided with information gathered concerning rod position changes at the time of the trip. This rod position indication showed that one or more rods may have started to fall into the core slightly before the majority of the rods. Due to unknowns about computer rod position indication (RPI) data acquisition and about RPI time response to free falling rods, this information could not be considered to be definitive. The voltage regulator for 21 MG set was replaced and tested satisfactorily. The MG set vendor concurred with the decision to replace the voltage regulator. The shutdown rods were again withdrawn and were observed for approximately five hours. It was then concluded that rod mechanism timing testing was not required and that the systems were operating correctly.

The response of substation 345KV breakers to the Unit 2 generator lockout (a design feature of the system) was not normal. One of the generator output breakers, 8H13, failed to open in the required time. This resulted in substation 345KV Bus 1 being de-energized. In turn, reserve and main auxiliary power were not available for the Unit 2 non-safeguards electrical buses. Auxiliary power was restored to Unit 2 after approximately three hours. The unit was in a hot shutdown, natural circulation condition during this time. All safeguards buses were powered via their alternate sources throughout the event. Since it was very cold at the time of the trip (-22 degrees F), it was assumed that the problem with breaker 8H13 was related to the cold weather. "Tents" were placed around several of the breakers in the substation and heating was applied. Breaker 8H13 was trip tested several times with satisfactory opening times. Based on these actions and test results, the cause of the slow opening time was concluded to be low temperature and the breaker was now operating properly. Unit 2 was placed in service at 0009 hours on December 23, 1989.

At approximately 1232 hours on December 26, 1989, Unit 2 reactor tripped. Subsequent to the trip, power to the Unit 2 non-safeguards 4KV buses was not available due to failure of 345KV breaker 8H13 in the substation. Both emergency diesel generators started but did not load since the Unit 2 safeguards buses remained powered by their alternate supplies. Power was restored to the non-safeguards buses and the reactor coolant pumps approximately two hours after the trip. Technical Specifications in effect on December 26, 1989 required one reactor coolant pump or one residual heat removal pump be inservice at all times. Technical Specifications allowed all pumps to be shutdown for up to one hour provided the reactor was subcritical, no dilution was in progress, and at least a 10 degrees F margin exists to saturation. All of the above criteria were met with the exception that the pumps were off for greater than one hour. Decay heat was being removed by the steam generators with the Reactor Coolant System in natural circulation.

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Since the unit was in hot shutdown and pumps resorted prior to the 6 hour requirement for hot shutdown, the intent of the Technical Specifications were not exceeded.

This trip and the response of 345KV substation breaker 8H13 was nearly identical to the trip on December 21.

Both the "first out" annunciator and the computer sequence of events indicated that the cause of the reactor trip was a high flux rate trip from the nuclear instrumentation system. A (negative) high flux rate trip is consistent with a dropped rod or rods. A check of the rod drive motor-generator (MG) sets showed that the output breakers of both MG sets were open. A check of the rod control system showed that no fuses were blown.

Two task forces were formed. Task Force One was to investigate the problems with breaker 8H13. Task Force Two was to investigate the problems with the rod drive MG sets.

Task Force Two obtained on-site services of the vendor. Test programs were formulated for the MG set voltage regulators and for their protective relaying. Equipment to monitor these areas was installed. While the MG sets were being monitored, two control rods from the shutdown banks, rod E03 and I11, dropped into the core but an Urgent Failure alarm was not received from the rod control system. This is contrary to the design of the rod control system. As a result, Task Force Three was formed to investigate problems with the rod control system. On-site vendor assistance was obtained for this effort as well.

Testing of the MG set voltage regulators and protective relaying continued. The testing showed that the dynamic response of the voltage regulators and of the protective relaying was not adequate to maintain a reliable power supply to the rod drive system under reasonably expected upset conditions. Further investigation discovered that the neutral bus had a ground. When it was determined that the ground did not exist in the MG set or the buses to the reactor trip breakers, Task Force Three was notified. It was determined that neither MG set voltage regulator was functioning adequately. Replacement regulators were obtained and inspected. After some discrepancies were resolved, the spare voltage regulators were bench tested satisfactorily. As-found data and conditions of the MG set systems were obtained. A loss of prime mover test was performed to determine the response to a loss of power similar to the power conditions that existed after the trips. This test showed that it is possible to trip one or both generator output breakers on a loss of power to the motors. Both replacement regulators were then installed. Testing of the protective relaying showed that the settings of the relays would not maintain reliable power to the rod control system while protecting the generator even though the settings were consistent with the technical manual recommendations. The relays and their input devices were determined to be in good condition. After the replacement voltage regulators were installed, the regulator settings and the protective relay settings were optimized to maintain a reliable power supply while still providing proper protection for the MG sets. As-left regulator wave forms were obtained and long term temporary monitoring instrumentation was installed. Performance will be monitored until the next scheduled outage.

Task Force Three began a testing program to address the problems in the rod control system. Some parts of the testing program had to wait for MG set availability, as the MG sets had been assigned the higher priority. Rod drive mechanism timing tests were performed for rods E03 and I11. The results of these tests disclosed "noise" in the current being monitored. Data from past mechanism timing tests were reviewed. The ground of the neutral bus reported by Task Force Two was determined to be caused by a faulty sampling resistor for rod C09. The possible effects of a grounded neutral were analyzed. It was concluded that grounding of the sampling resistor in the power cabinet should not affect another power cabinet.

The defective resistor was replaced. Additional monitoring equipment was installed to determine the source of the noise spikes noted earlier. Shutdown bank rods were withdrawn from the core. Again rods E03 and I11 dropped after they were withdrawn with no Urgent Failure alarm being generated. The Urgent Failure alarm circuit board was replaced after it was determined to be faulty. When "V-ref", a signal used to control current to the rod mechanisms, was noted to be intermittently low in power cabinet 1AC, selected areas of the "V-ref" circuit path were instrumented. The system was monitored and a mechanism timing test of all rods was performed. All rods were tripped from the fully withdrawn position in an attempt to establish the quality of the rod position indication data acquired by the computer during the previous reactor trips. The trip test data generally supports the conclusion that both reactor trips were caused by the dropping of rod E03 and perhaps an additional rod or rods. It is believed that the failure of the Urgent Failure alarm circuit (which is designed to prevent rods from dropping in the event of control system problems), in conjunction with an intermittent V-ref signal, caused at least rod E03 to drop, initiating the trips. Four circuit boards in the path of "V-ref" in power cabinet 1AC were replaced and a mechanism timing test was performed on the rods powered by that cabinet, E03 and I11. The Urgent Failure alarm circuits in the remaining power cabinets were verified to be operable and the Unit 1 rod control system neutral-to-ground potential was checked and found to be satisfactory. Long term temporary instrumentation was installed. Performance will be monitored until the next scheduled outage. The circuit boards that were replaced have been sent to the vendor for failure analysis.

Task Force One began a testing program on substation breaker 8H13. Historical data from past unit trips during cold weather were reviewed and showed no previous problems associated with this type of breaker at temperatures as low as -10 degrees F. Services of a consultant were obtained. While preparing to perform trip time testing, clearances of the C phase trip armature were observed to be improper. This time the testing showed the opening time of C phase to be slow. Inspection of this armature showed inadequate clearances and high push-off forces. Both of these can cause a breaker to open slowly. Wear or galling were noted when the assembly was disassembled for inspection. No spare assemblies were immediately available. Replacement parts were expedited. Breaker 8H14, the other Unit 2 generator output breaker, was inspected, tested and determined to be in good condition and to operate properly. Operation with only 8H14 in service was evaluated and determined to be acceptable.

Unit 2 was returned to service at 1618 hours on January 10, 1990.

Breaker 8H13 was later repaired, extensively tested, and returned to service on January 17, 1990.

Long-term corrective actions will include review and revision of the preventive maintenance programs for the breakers and the rod control system. Information gained from further monitoring will be factored into those revisions.

ANALYSIS OF THE EVENT

This event is reportable pursuant to 10CFR50.73(a)(2)(iv) and 10CFR50.73(a)(2)(i)(B). Plant response to the trips was as expected except for loss of power to the non-safeguards 4KV buses, which supply the reactor coolant pumps. The reactor was cooled by natural circulation while power was being restored to the pumps. Safeguards buses were unaffected. These events had no effect on public health and safety.

FAILED COMPONENT IDENTIFICATION

Westinghouse supplied motor-generator set:

Westinghouse Motor Rating: 150 hp, 1750 rpm, 460 VAC,
3 ph, 60 Hz, Frame 444-TS, Starting - NEMA Code F

Electric Machinery Alternator Rating: 438 Kva, 0.8 PF, 1800 rpm, 260 VAC, 3 ph, 60 Hz, Frame 727
Westinghouse "Thyrex" Voltage Regulator, Size TRX-2 Sub 1

Westinghouse Full Length Rod Control System

General Electric Outdoor Air-Blast Circuit Breaker Type
ATB-362-7, 362 KV

PREVIOUS SIMILAR EVENTS

There have been no previous similar events at Prairie Island.

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Figure 1 omitted. (no title available)

TEXT PAGE 10 OF 10

Figure 2 omitted. (no title available)

ATTACHMENT 1 TO 9003270415 PAGE 1 OF 1

Northern States Power Company

NSP 414 Nicollet Mall
Minneapolis, Minnesota 55401-1927
Telephone (612) 330-5500

March 19, 1990 Report Required by
10 CFR Part 50, Section 50.73

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket No. 50-282 License No. DPR-42
50-306 DPR-60

Revision 1
Unit 2 Reactor Trips and Loss of Power to
Reactor Coolant Pumps

A revised Licensee Event Report is attached.

Please contact us if you require additional information related to these events.

Thomas M Parker

Manager
Nuclear Support Services

c: Regional Administrator - III NRC
Sr Resident Inspector, NRC
NRR Project Manager, NRC
MPCA
Attn: Dr J W Ferman

Attachment

*** END OF DOCUMENT ***
